

USAWC STRATEGY RESEARCH PROJECT

A PROPOSAL TO RETHINK THE WAY
WE DEVELOP NATIONAL MILITARY
STRATEGY: MORE SCIENCE, LESS ART

by

Lieutenant Colonel Timothy E. Gowen
United States Army National Guard

Doctor James B. Bartholomees
Project Adviser

This SRP is submitted in partial fulfillment of the requirements of the Master of Strategic Studies Degree. The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, (215) 662-5606. The Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

The views expressed in this student academic research paper are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 18 MAR 2005		2. REPORT TYPE		3. DATES COVERED -	
4. TITLE AND SUBTITLE A Proposal to Rethink the Way We Develop National Military Strategy More Science, Less Art				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Timothy Gowen				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army War College, Carlisle Barracks, Carlisle, PA, 17013-5050				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT See attached.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 28	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

ABSTRACT

AUTHOR: Lieutenant Colonel Timothy E. Gowen
TITLE: A Proposal to Rethink the Way We Develop National Military Strategy: More Science, Less Art
FORMAT: Strategy Research Project
DATE: 18 March 2005 PAGES: 28 CLASSIFICATION: Unclassified

This paper proposes that strategy be developed with the assistance of a national military strategic mathematical model generated from careful analysis of the national and military situation; one that reflects a system of mathematical equations that are refined over time with continuous updates from current events; one that can provide the means to carefully analyze the various courses of actions with factual scrutiny, based on statistics, probabilities, and objective relationships, especially with respect to force projection.

Utilizing the various tenets of classic military theorists tied to the concepts of scientific method and advanced modeling procedures, it is feasible to develop this analytical tool. Once this system was developed, the country would have one of the most important weapons ever created. The value of an analytical tool that can reliably predict the best course of action for every objective, every scenario, and every crisis is priceless in terms of lives saved and security maintained. The effort involved and the resources expended to create such a tool would be relatively small and practically a moral obligation of military and civilian leadership to the citizens of this country.

TABLE OF CONTENTS

ABSTRACT.....	iii
A PROPOSAL TO RETHINK THE WAY WE DEVELOP NATIONAL MILITARY STRATEGY: MORE SCIENCE, LESS ART	1
THE CASE FOR MORE SCIENCE, LESS ART	1
CLASSIC THINKING REGARDING THE “ART” OF MILITARY STRATEGY.....	3
DEVELOPING THE SCIENTIFIC MODEL	8
RECOMMENDED PROCEDURES OF CLASSIC THEORISTS	8
RECOMMENDED PROCEDURES OF MODERN THEORISTS	10
METHODOLOGY REQUIRED TO DEVELOP MODELS FOR COMPLEX SYSTEMS	11
MATHEMATICAL MODELING OF STRATEGY.....	12
IS A SCIENTIFIC MODELING TOOL DESIGNED TO BE USED TO DEVELOP STRATEGY A SUITABLE, FEASIBLE, AND ACCEPTABLE SOLUTION?	14
ENDNOTES	17
BIBLIOGRAPHY	21

A PROPOSAL TO RETHINK THE WAY WE DEVELOP NATIONAL MILITARY STRATEGY: MORE SCIENCE, LESS ART

THE CASE FOR MORE SCIENCE, LESS ART

The most knowledgeable, capable, historically astute, military and government professionals in the world are still not sufficiently capable of determining effective national military strategy. This assertion has been proven repeatedly in contemporary American military history: in Korea, in Vietnam, and in most recently, in Iraq. Failed strategy has been responsible for the loss of countless American lives as well as squandered resources and depleted credibility. American military professionals need to reevaluate the traditional method used to craft military strategy. It is not the theoretical aspect of strategy that befuddles Americans; as an organization, members of the American military community are among the most well trained, well educated strategists in the world today. The problem arises with the correct application of that knowledge. With all the modern, high speed computers and advanced information networks at our disposal, the American military community still relies on human instinct and personal intuition to decide military strategy; the same strategy that we depend upon to protect America's most cherished resources: the sons and daughters that serves as soldiers, sailors, airmen, and marines.

There are numerous historical examples where flawed strategy played a significant role in the outcome of military events. The defeat of the Eighth United States Army in Korea from November to December, 1950 is one such example. The unsuccessful strategy in that event was a result of the failure of American planners and leaders to correctly anticipate the behavior of the Red Chinese forces. Despite a plethora of unambiguous warnings, including prisoner-of-war interrogations, espionage, and direct communications with the Chinese, Americans failed to predict China's entry into the war.¹ General MacArthur, blinded by his own agenda, and his staff, blinded by their pre-conceived notions of the overall intentions of the Chinese, failed to see their inevitable entry into the war as a logical course of action. With the benefit of hindsight, however, China's entry looks perfectly logical, albeit understandably obscured by the misleading events of the moment. The long-term result of this debacle has been protracted stalemate that has cost Americans billions of dollars and unfathomable quantities of military resources over the course of the last 55 years (and counting). To make a bad situation worse, North Korea has emerged as a nuclear threat and a sponsor of terrorism. MacArthur's staff could certainly have benefited from an improved method of determining strategy - one that relied less on human presentiment and more on objective examination.

More recently, some contend that Vietnam was lost, among other reasons, because of failed strategy. In his latest book, *Supreme Command: Soldiers, Statesmen, and Leadership in Wartime*, Eliot Cohen blames the tragic loss in Vietnam, along with the lives of 60,000 young Americans, predominantly on President Johnson and Secretary of Defense McNamara's lack of sensible strategic thought.

To be sure...the centrally controlled bombing of Vietnam—the modulated application of violence—resulted from a theory of strategic signaling and gradual escalation that proved calamitously false. The Communist leadership in Hanoi was simply too determined, too tough, too willing to accept suffering to yield to graduated pressure—or to “diplomatic” signals conveyed by bombs whistling their way into power stations or radar installations. Johnson and McNamara operated from a false strategic concept—a “theory of victory” that rested on a radically inadequate understanding of the opponent and, for that matter, of their own society. The argument thus becomes less a question of how they exercised civilian control than one of how well—or poorly—they thought about strategy.²

Cohen's excerpt portrays a fine example of how leaders with the best of intentions can develop failed strategy when they are forced to rely on their own intuition. Even leaders armed with knowledge of Clausewitz and a complete grasp of the disposition and capabilities of all the military elements involved can develop flawed strategy if they base their decisions on personal notions, intuition, or political motives. And for the staff or subordinate leaders the flawed ideas of senior leaders are especially difficult, if not impossible, to challenge because of their inherent subjectivity. The staff or subordinate leaders cannot easily challenge a subjective line of reasoning by simply proposing to replace it with yet another subjective line of reasoning.

The problem is that for the most part strategy today is developed based on “art” as opposed to a rigorous procedure founded in scientific method. Military planners and leaders lack the ability to develop strategy with the assistance of a national military strategic mathematical model that has been developed through careful analysis of the situation; one that is captured in a system of mathematical equations that have been refined over time with continuous updates from current events; one that can provide the means to carefully analyze the various courses of actions with factual scrutiny, based on statistics, probabilities, and objective relationships, especially with respect to force projection.

At the outset of the Iraq War the American military profession once again found itself in a strategic dilemma. The basic question at hand was to determine the correct number of troops required in all phases, but especially the stabilization phase of the operation. Some planners felt a 40:1 or 50:1 ratio was necessary (one soldier for every 40 to 50 inhabitants) based on the requirements for operations in Germany after World War II or the Kosovo Campaign.³ Others stressed that it was not the number of troops, it was how those troops were used and what their

capabilities were.⁴ But in the end, whether the number of troops that deployed was the right amount, too many, or too few was still a matter of great debate. Unfortunately for the American military, politicians, and the public, there was no objective model with which to compare their proposed strategy -only subjective opinion.

In this day of great electronic analytical capability with giant super-computers and amazingly accurate mathematical models for a wide array of complex systems from tilt-rotor aircraft to diverse social-political opinion, there is no good excuse to rely solely on the hunches of military and government leaders to create wartime strategy. Edward N. Luttwak, a twentieth century military theorists, warns his readers of the “paradoxical logic of war.” Paradoxical logic is that which tells a planner that in combat a bad road is good (because the enemy must think it is too bad to use – so it must be good).⁵ Paradoxical logic is that which tells the leaders of one country to build up their arsenal in order to be prepared to defend themselves, not realizing that the neighboring country will attack preemptively, fearing that the buildup will leave it vulnerable.⁶ With so much at stake, national military strategy should not be left to the intuition of leaders; it should be based on rigorous, scientific method and created with all the best tools of technology. While the American military community today takes full advantage of such technology to test strategy by using high-powered war game technology and to implement strategy by using applications that develop and execute deployment schedules for full scale operations, the development of the baseline national military strategy is viewed by most theorists and national leaders to be more of an art than a science.

CLASSIC THINKING REGARDING THE “ART” OF MILITARY STRATEGY

Most military professionals, historians, and strategists would disagree with the proposal to resort to science while in the pursuit of a successful campaign strategy. Most of the notable classic military theorists tend to disagree with such a proposal as well. Karl von Clausewitz, perhaps the most esteemed of all military theorists, held a distinct opinion on the subject:

We must admit that wherever it would be too laborious to determine the facts of the situation, we must have recourse to the relevant principles established by theory. But in the same way as in war these truths are better served by a commander who has absorbed their meaning in his mind rather than one who treats them as rigid external rules, so the critic should not apply them like an external law or an algebraic formula whose relevance need not be established each time it is used. These truths should always be allowed to become self-evident, while only the more precise and complex proofs are left to theory.⁷

According to Clausewitz the information necessarily gathered to formulate strategy was far too subjective to be used as “prescriptive formulation.”⁸ Further, moral and psychological forces

entangle with physical forces to create an environment too complex to determine through scientific axiom and law. Clausewitz also believed that since war is a series of reciprocal actions, and it is impossible to be sure what the enemy might do, developing strategy will always require a great deal of subjectivity.⁹

Ironically, although Clausewitz opposed the idea of using rigorous scientific method to determine strategy, his own works were filled with references and apparent comparisons to physical sciences. Most notably, Clausewitz used the term “center of gravity” to describe “the hub of all power and movement, on which everything depends [and] the point against which all our energies should be directed.”¹⁰ The term “center of gravity” was originally derived from the physical sciences. Similarly, the physical sciences version of center of gravity is a “hub of all power and movement” for selected mechanical systems. Clausewitz borrowed meaning for his most critical terminology from science. In addition, Clausewitz used the term “friction,” which again was used in a very similar context to the analysis of a physical system. In one final example, although there are others, Clausewitz referred to the economy of force, which refers to the efficiency of the military forces but which is similar to the overall efficiency of a mechanical system. From these examples one can see that Clausewitz was at least willing on some level to accept the value of the use of scientific concepts to characterize strategy.

Although efficiency, friction, and centers of gravity are measurable and quantifiable, Clausewitz opposed quantifiable determinations with respect to military strategy. He felt it was far too complex to assign numerical amounts to forces or any other aspect of military strategy. He said, “...to accept the superiority of numbers as the one and only rule, and to reduce the whole secret of the art of war to the formula of numerical superiority at a certain time in a certain place was an oversimplification that would not have stood up for a moment against the realities of life.”¹¹

Antoine Henri Jomini is another classic strategic theorist from the same era as Clausewitz. Born in Switzerland, full general in the Imperial Army of the Czar, and author of *Summary of the Art of War*, which has directly or indirectly influenced American generals since the Civil War, Jomini is commonly considered a determinist: one who embraced a theory of war based on indisputable principles.¹² Jomini is best known for producing theory that was based largely on geometric order. For this he received great criticism, compelling him to rebut. He stated in *Summary*, “...these figures have never been of any other use than to indicate approximate arrangements.”¹³ He went on to say, “nothing is better calculated to kill natural genius and to cause error to triumph, than those pedantic theories, based upon the false idea that war is a positive science, all the operations of which can be reduced to infallible calculations.”¹⁴ But in

spite of his stated position, Jomini went on to provide thirteen items of importance regarding strategy as well as four specific principles of war and several very specific axioms regarding the theater of operations; bases of operations; strategic, decisive, and objective points; and zones of operations.¹⁵ Many of these principles are articulated in terms of relationships that can, with a robust systems approach, be expressed in quantifiable, comparative formulae.

The well known ancient Eastern military philosopher Sun Tzu has been celebrated for creating simple axioms that referred to human values and emotions, especially with respect to general warfare. But he also had a propensity to occasionally boil strategy down to simple quantifiable relationships.

It is the rule in war, if our forces are ten to the enemy's one, to surround him; if five to one, to attack him; if twice as numerous, to divide our army into two. If equally matched, we can offer battle; if slightly inferior, we can avoid the enemy; if quite unequal in every way, we can flee from him. Hence, though an obstinate fight may be made by a small force, in the end it must be captured by the larger force.¹⁶

This seemingly simple principle, if taken at face value, can certainly be made into a quantifiable set of equations from which to base robust strategic formulation. Critics may argue that Sun Tzu's rules of strategy are too general and are therefore not very useful or likely to work for many situations. However, for their time they were certainly a positive first step toward the proper incorporation of mathematical and scientific structure into the formulation of strategy.

One of the more modern strategists, Admiral John C. Wylie who wrote of military strategy in the second half of the twentieth century, while not committing to the formulation of strategic laws similar to physical laws, recognized the need for a scientific approach to development of strategy. Most importantly, Wylie recognized that military strategy has been a field neglected by academics and scientists. He felt that due to the magnitude of its importance on the world scale, military strategy should finally be analyzed more seriously in the scientific sense. Wylie contends:

Of all the great fields into which human energy has been directed, certainly war has caused more trouble than any other. Death and destruction and heartbreak, political upset and economic chaos and social disorder - war involves them all. Yet the scholars have managed with almost serene indifference to ignore the problem of the theories of war and their effect on the conduct of war. ¹⁷

Without asserting that military strategy could or should be translated into formal scientific theorem, he did emphasize that if theories were to exist, they should comply with notions of scientific reason. He stated, "If any two theories of strategy are not compatible, then neither of them is a valid general theory."¹⁸ But still, Wylie recognized the inherent difficulty with the

process of quantifying and capturing the human dimension. As Wylie put it, "It is very difficult to put a statistical probability in one column and a human judgment in the other and compare them. We do not yet have the techniques for that except in another human judgment. It is the nature of the strategic theories that limits the application of the mathematical analyses in the management of the tools of war."¹⁹

While military professionals, theorists, and strategists generally oppose the idea of pursuing a rigorous scientific technique of formulating strategy, T.N. Dupuy, a modern historian and theorist, embraced the idea. Dupuy's theories are heavily dependent on statistics, equations, and formulas and seem intuitive, at least for the operational level of war. Dupuy introduced the Quantified Judgment Method of Analysis, which is an "analytical methodology that [he] has been primarily responsible for developing and perfecting."²⁰ A major component of this methodology is the Quantified Judgment Model that Dupuy admitted was the result of a somewhat messy process of trial and error.²¹ Dupuy showed in an extensive and lengthy formula that "force strength" is linear and varies as a function of weapon effectiveness, terrain, weather, season, and air superiority factors that vary with respect to armor, artillery, infantry, or air support systems. He continued to show that "combat power potential" is a linear relationship of "force strength" (which is further defined), mobility factor, leadership factor, training, morale factor, logistics factor, posture factor, terrain factor, weather factor, and vulnerability value. All the various "factors" and "values" are presented in tabular form for a variety of conditions and presumably have other relational values as well.²² Overall, with respect to traditional scientific method, DuPuy can easily be criticized for creating empirical formulae (setting equations to fit the available data) that are not backed by mathematical or scientific theory. Further, DuPuy's Quantified Method is only truly useful for analyzing historical battles. However, he does present at least one example in which he used his methods to analyze the relative force effectiveness of U.S. and Soviet weapon systems.²³ An objective analysis of DuPuy's methodology would likely find his theorem to contain only casual relationships too dependent on experiential scenarios. But with all his shortfalls, only time will tell whether DuPuy was a pioneer in *scientific* discipline of the development of strategy.

The debate surrounding whether to rely more on science or art while developing strategy and whether it is even possible to fully utilize robust scientific method in this regard was played out in detail in the national security journal *Security Studies*. The debate began within the publication of *Bombing to Win: Air Power and Coercion in War* by Robert Pape. In *Bombing to Win*, Pape examined the strategic effectiveness of bombing campaigns by using scientific methods and careful analysis of systematically collected evidence. His conclusions drew serious

refutation from air power proponents, not just for his condemnation of air power theory, but for his scientific method of analysis. *Security Studies* published this debate as a series of articles and rebuttals between Pape and his two challengers - Barry Watts, the director of the Northrup Grumman Analysis Center and John Warden, the former Commandant of the United States Air Force Command and Staff College. Warden mainly took issue with Pape's conclusions regarding the usefulness of strategic bombing. Watts too questioned Pape's conclusions, but at the same time had serious reservations regarding Pape's methods of analysis. Watts asked, "can the messy, intractable, contingent phenomena of actual war be adequately addressed by a quasimathematical, predictive theory modeled on the approach Isaac Newton took...to natural phenomenon such as celestial mechanics?"²⁴ Watts asserted that "war and international politics lack the regularity and predictability [to resort to mathematical methodology in their analysis]."²⁵ He based this assertion on the conclusions made by social scientists who originally introduced the notion, stating that they no longer subscribe to this paradigm due in part to the developments in the fields of quantum mechanics and nonlinear dynamics.²⁶ Watt's second reason for doubting Pape's methods was the inevitable introduction of second and third order effects produced by social or political interaction, thereby making accurate prediction impossible. Finally, Watts stated that one should not overlook the "special force that chance, uncertainty, indirect effects, unintended consequences, human errors and frailties, and numerous other non-linearities have exerted on the outcomes of actual war," citing Clausewitz's distinction between "war on paper" and real war."²⁷

In rebuttal, Pape pointed out that "the essence of science is the use of scientific method" and that "above all else, a commitment to the use of observable evidence to verify or falsify cause and effect hypothesis in a manner which avoid arbitrary, ad hoc assessments of a particular case"²⁸ is the central concern in the use of science. Pape argued that while it may not be easily discernible, there is in all likelihood, at least some degree of regularity in the social science of human interactions with respect to war. If this were not true, then there is no sense in studying war whatsoever, and we would forever be doomed to repeat history. Further, he argued that "if social outcomes are really so random and inconsistent that they lack identifiable patterns, there would be no point in studying history, and that there could be no such thing as an expertise, particularly a military expertise."²⁹ There could be simply no ability to predict whatsoever. Fortunately, there are repeatable cause and effect relationships in war, and policy makers can benefit from previously similar circumstances and outcomes. Pape then proposed that policy makers like the president do not have the luxury of assuming that prediction is too

hard. For that reason, it is the duty of strategists and military theorists to pursue the concept of reliable scientific method in developing military strategy.³⁰

One can easily see that there are formidable positions on both sides of the debate. The classic theorists argued against the notion of quantifying the process by which national military strategy is developed, but their own works provide at least some foundation in numerical solutions. More modern theorists recognize that the “art” could stand some improvement using modern scientific methodology, but still contend that strategy should be based on intuition. But the force of science is growing ever stronger and more persistent, and the possibility of improving the national military strategic development process through scientific method and mathematical modeling should at least be evaluated.

DEVELOPING THE SCIENTIFIC MODEL

This paper argues that scientific method should be used to determine national military strategy. Thus far, we have shown that this idea bears consideration, but is it even possible? In order to develop a rigorous method of formulating strategy it is necessary to combine the philosophical, nonlinear, qualitative approach to strategic studies with the mathematical, quantitative, linear modeling method usually used to analyze systems, complex or otherwise. Classic military theorists have provided ample opinion regarding the fundamental principles of military strategy. But they also often provided recommendations on *how* to develop military strategy. We will review the recommended procedures of the classic strategists Clausewitz and Jomini and also modern strategists Wylie and Lykke. Following this, we will analyze the methodology required to develop models for complex systems, including social, political, and military-political systems. From there, we will appraise the prospect of combining the two fields of study and finally we will study some existing rigorous methods of analysis for the operational and strategic levels of war.

RECOMMENDED PROCEDURES OF CLASSIC THEORISTS

The Eighth and final book of *On War* is entitled “War Plans”. In it, Clausewitz proposed a methodology to use the vast array of theory on military strategy that he has provided in the previous seven books. Ever consistent, Clausewitz warned not to try to find the geometric solution to military strategy. In so doing he advised that “[t]heory cannot equip the mind with formulas for solving problems, nor can it mark the narrow path on which the sole solution is supposed to lie by planting a hedge of principles on either side.”³¹ But again, he did not shut the door completely on the prospect of establishing a linear system for analysis and prediction when

he immediately followed with, "But it can give the mind insight into the great mass of phenomena and their relationships then leave it free to rise into higher realms of action."³² Clausewitz recognizes here, that there are *relationships* between the phenomena of war. As we shall see, relationships form the foundation of a scientific analysis.

Clausewitz's method for developing strategy begins with defining an objective. "No one starts a war—or rather, no one in his senses ought to do so—without first being clear in his mind what he intends to achieve by that war and how he intends to conduct it."³³ Clausewitz established with this statement and the subsequent explanation that it is necessary to determine the political purpose and the operational objective, especially if the objective is a limited solution (vice the total defeat of the enemy). The next step in his process was to attempt to gather and capture the ever present complexities of war in a somewhat logical fashion. In rather ambiguous terms he stated,

No logical sequence could progress through their innumerable twists and turns as though it were a simple thread that linked two deductions. Logic comes to a stop in this labyrinth; and those men who habitually act, both in great and minor affairs, on particular dominating impressions or feelings rather than according to strict logic, are hardly aware of the confused, inconsistent, and ambiguous situation in which they find themselves.³⁴

In the next steps of his process Clausewitz speculated that one must determine the elements of war and their interdependence. Degree of force, political demands, strength of will, character, abilities, ability to mobilize and the scale of mobilization required, strength and situation of the opposing state, cash resources, treasury, credit, and the backing of the population are some of the elements Clausewitz hypothesized must be gauged in order to determine a correct strategy.³⁵ His next step was to plan for the defeat and destruction of the enemy's fighting force. He laid out three approaches to accomplish this feat: 1.) destruction of his army; 2.) seizure of his capital; 3.) striking an effective blow to his principal ally.³⁶

Subsequent chapters of *On War* contain numerous step-by-step methodical instructions for conducting war. For example, Clausewitz provided systematic directions on how to conduct offensive operations and detailed instructions for how to roll up an enemy from the left flank.³⁷ Further, Clausewitz devoted an entire chapter to the interdependence of politics and military operations in the conduct of war; a relationship that should be necessarily accounted for in the development of a scientific strategic model.³⁸ In the final chapter of *On War*, Clausewitz laid out a fairly orderly process for developing a plan of war for the *total* defeat of the enemy, as opposed to limited warfare.³⁹ Although it is based on *guiding* principles, Clausewitz's methodical instructions on how to conduct war would almost certainly lend itself well to codified language.

In *Art of War*, Jomini took an approach almost exactly opposite to Clausewitz. Unlike Clausewitz, who provided general principles and specific methodical instructions for implementation, Jomini provided specific rules of war but vague direction or guidance pertaining to the creation of a strategic plan. For example, Jomini listed the thirteen principles of strategy, ranging from the selection of the theater to points for camps and diversions.⁴⁰ He catalogued the four maxims or principles of war.⁴¹ He cited, in detail, the nine important features of a theater of operations.⁴² He even provided the rules for selecting tactical positions and the twelve essential rules necessary for a perfect army.⁴³ But aside from providing a short, sketchy list of the times when a government should go to war, Jomini falls short of providing a detailed set of instructions for planning or creating strategy.

RECOMMENDED PROCEDURES OF MODERN THEORISTS

Like all of J.C. Wylie's philosophy on strategy, his approach to developing a strategic plan for implementation is relatively direct and straight forward. Wylie contended that the strategist should first exert some degree of control of the enemy by selecting the outline of thought, the scene, or the pattern of war (e.g., maritime, continental, air, or insurgency). This step is accomplished by manipulating the center of gravity to the advantage of the friendly nation and the disadvantage of the opponent. The next step is to control the nature, placement, timing, and weight of the center of gravity. Finally, exploit the resulting pattern of war toward the strategist's end.⁴⁴ Wylie's process is not very detailed or helpful to the student of strategy, especially when it is taken out of the context of the rest of the material contained in *Military Strategy*. In addition, Wylie's work did not contain any original ideas relating to the development of strategy. Instead he relied on the works of other theorists such as Clausewitz, Mao, Douhet, and Liddell Hart to provide the development process. However, his strategic process is relatively straightforward and when combined with the basic principles of warfare, could lend itself to a systematic model.

Arthur F. Lykke proposed an elegant method of modeling strategy and a subsequent formulation model for national strategy. Lykke posited that strategy is composed of objectives, courses of action, and instruments by which the objectives can be achieved. Put more simply: strategy is a relationship of ends, ways, and means. Further, Lykke believed the strategy developed must balance these three elements (ends, ways, and means), in order to avoid significant risk. Lykke presented a very simple model for determining national security strategy, centered on the trilateral balance between ends, ways, and means.⁴⁵ In addition, this model called for a determination of feasibility, acceptability, and suitability, followed by an overall risk assessment of the strategic concept. Lykke's model is intuitive and simple, and ensures a

process that hones the resultant strategy to within certain constraints. However, since the development of a grand strategy is simply a step in the process, this model would most likely only be helpful in providing the framework for the military strategy model we seek.

METHODOLOGY REQUIRED TO DEVELOP MODELS FOR COMPLEX SYSTEMS

We have seen many of the general processes that classic and modern strategists have devised to create strategy. Next we shall examine the processes and the tools used by engineers, scientists, and mathematicians who routinely model complex systems. The objective of the modeler is to translate all the knowledge of a system into mathematical equations that can then be manipulated and exploited to form a predictive model that produces reams of data from which to perform analysis. A key step in this task falls to the mathematician. The mathematician must translate substantive ideas regarding the immense system at hand into precise, mathematical statements. In any modeling project the type of modeling system employed depends on the complexity of the system. There are four different types of models a mathematician can employ. The simplest of models is the first-order linear differential equation with constant coefficients. This model uses a time series of a single state variable with only a single variable.⁴⁶ This model could be used to depict the build up of forces in a specific operational zone over time.

The second model is a first-order nonlinear differential equation with constant coefficients. This type of equation is slightly more complex than the first model in that it employs a second order variable, but the use of this equation provides a more complete and more useful result. Use of this type of model for social interaction has shown the capability to predict equilibrium and qualitative behavior over time. Possible uses for this equation could include the depiction of population demography or rapid changes in public opinion.⁴⁷

The third model available is the system of first order linear equations. This model is useful in capturing interdependence among variables. This particular modeling system has often been used to model such complex systems as an arms race, economic or financial systems, or feedback models such as legislative interaction.⁴⁸

The final model is the system of nonlinear equations. This model format involves multiple variables and multiple sets of equations, and it enables the mathematician to capture complex interdependence.⁴⁹ This modeling system has been used to model such a multifaceted yet thorny system as the budgeting process. It is therefore likely that this would be the one most useful and most suitable approaches for the development of national and military strategy.

MATHEMATICAL MODELING OF STRATEGY

So what process should one follow to determine the set of equations that equates to the complex national military system? Typically, the scientist modeling the system employs scientific method in order to determine the interdependence and relative values of variables that will be used to create the model. Scientific method requires five fundamental elements.

1. Causal Generalization. Scientific method and subsequent mathematical modeling requires the existence of an "if-then" relationship between two or more variables.
2. Operational Definitions of Variables. It is necessary to establish set parameters for the measurement of variables to avoid ad hoc interpretation that lead to the introduction of imprecise results.
3. Co-variation. This is the process by which one determines whether the causal relationship is present only when hypothesized: no more, no less.
4. Controlled Comparison to Eliminate Alternative Explanations. Tests should be conducted to verify that the result provided is due to the hypothesized reasoning and not due to an alternative relationship.
5. Deductive Theory. All theories can lead to a multitude of results, depending on changing circumstances down the line of analysis. Properly constructed models should enable the scientist to sort through a variety of conditions, while tracing back to the original baseline theory.⁵⁰

Determining the set of relationships between variables in a national military strategic system can be a daunting undertaking. Some would say it is impossible to capture the complexities of such a convoluted system, particularly when one considers the instabilities involved, to include: policy, capabilities, alliances, national and international opinion, current events, unstable governments, and the motives of politicians. However, there are at least some theorists who claim it is still possible to model such complex systems.

In the broadest sense, Ludwig von Bertalanffy was a pioneer in the development of models of complex systems, especially those that involved human interaction and social circumstances. Bertalanffy developed the General Systems Theory that provided psychologists a more empirical method of examining problems. The overall concept of this theory is that a psychologist or a sociologist can utilize "the ability to obtain information from other sciences that can give an advanced explanation."⁵¹ For example, one can use laws of physics or thermodynamics to determine the likely reasoning for social-human behavior. This concept allows for a holistic, systems approach to modeling human interaction, and it has been well accepted by social scientists. In fact, the social science discipline has made great progress in

the domain of modeling complex social systems as well as political sciences. Virtually every social or political science journal or book contains an article describing improvements in some facet of a particular model of the complexities of society.

Creating a rigorous mathematical model of war is not a new concept. Frederick Lanchester, a British mathematician applied mathematical analysis to warfare dating back to 1916. Lanchester's theory on the principle of concentration (similar to the principle of *mass*) sought to justify the concept whereby it is optimal strategy to concentrate one's forces on a definite object. He created a set of second order linear differential equations considering the numerical strengths of two armies over time that amounted to a simple model of the attrition that could vary with respect to the strengths of assigned weapons systems. It was a simple, elegant model that captured the time varying strengths of opposing forces at the operational level. Over time, many other modelers used Lanchester's original works to create more complex versions. For example, Alan Karr created "A Generalized Stochastic Lanchester Attrition Process" using Lanchester's theory which could account for four categories of weapons classifications.⁵²

The aforementioned Colonel T.N. Dupuy took the mathematical modeling of warfare to a whole new level. In his book *Understanding War: History and Theory of Combat*, Dupuy used formulae, statistics, and algebraic equations to model everything from attrition to friction to force multipliers.⁵³ Colonel Dupuy used Lanchester Equations to evaluate historical data and used his own Quantified Judgment Model to apply mathematical concepts to Clausewitz. Dupuy's models depend a great deal on look-up tables for quantifiable data, and his analysis is more geared to analysis of history than as a predictive tool; however, much of this work could be combined with other works to formulate a more robust mathematical model useful for the formulation of strategy.

Perhaps the most rigorous form of analysis of warfare at the operational level is that of Stephen Biddle. Biddle's *Military Power: Explaining Victory and Defeat in Modern Battle* shows the reader why wars are won in modern terms as he introduces an analysis of the modern system of force employment. Along the way, however, Biddle evaluated modern techniques of analysis.

Today most analysis are either rigorous but narrow, or broad but unrigorous. Mathematical models of combat, for example, are rigorous but typically focus on material alone: how many troops or weapons do the sides have, and how good is their equipment? By contrast, holistic assessments consider issues such as strategy, tactics, morale, combat motivation, or leadership as well as just materiel but treat these variables much less systematically.⁵⁴

Biddle stressed that mathematics is simply an alternative form of language, and that it is useful to “describe causal relationships [and there are] advantages in sorting out the internal logic of complex, interconnecting claims. It also facilitates inference from observations of the past to conjectures about the future.”⁵⁵ Of the current use of mathematical modeling of military warfare, Biddle stated, “modelers usually consider it too hard to measure and too multidimensional to theorize. Instead they focus on chiefly representing particular weapon types and numerical balances, often in tremendous detail, usually with a single, officially sanctioned military doctrine ‘hardwired’ into the model’s mathematics as an enabling assumption.”⁵⁶

Biddle’s own mathematical modeling of operational warfare in *Military Power* is very robust. He creates a “formal model of capability” in which he formalizes the presentation of theory in ten steps.⁵⁷ Incidentally, these steps match the aforementioned scientific method. Biddle’s mathematical methods are an excellent example of proper use of modeling in the analysis of warfare.

There are two drawbacks to Biddle’s model if it were to be considered to be useful in the determination of strategy. One is that it is oriented toward the operational level of war. In order to develop a model that is useful for the creation of military and national strategy, the model must be optimized for the strategic level. Fortunately, there are some excellent examples of strategic level models that have been developed with the same rigor as Biddle’s work. Ian Bellany’s “Modeling War” is one such example.⁵⁸ In addition, while Biddle’s and Bellany’s work is excellent for determining the disposition and strength of forces as a function of time, this system is not necessarily useful to *determine* strategy. Most models for combat in the field today are combat simulation models that build on tactical or operation models. These models, like Biddle’s, are inherently time dependent and not especially suited for the development of strategy. The independent variable that should be utilized in a more suitable strategy model might be based on the elements of national power: military force, information, legal, diplomacy, intelligence, finance, and economics.

IS A SCIENTIFIC MODELING TOOL DESIGNED TO BE USED TO DEVELOP STRATEGY A SUITABLE, FEASIBLE, AND ACCEPTABLE SOLUTION?

We have shown that the current methods of developing strategy that rely predominantly on the intuition of the leader or strategist have produced insufficient results. In addition, we have shown that although classic theorists oppose the concept of using scientific method or mathematical means to develop strategy, some more modern theorists have used the more rigorous approach. Finally, we have proposed a scheme to develop a scientific approach to

strategic development that combines scientific method, mathematical modeling and classic theory. But would this produce a strategy that enables the leadership to accomplish the national mission? Would it accomplish this task with available resources? And, would the advantages of this methodology balance costs and risks?

The methods proposed by this scientific and mathematical approach to strategy in all likelihood would not produce instant success. Success in modeling complex systems is dependent on how well the overall model can be adapted to known results, or "truth." As the model is initially developed, scientists will require truthful data to input into the system in order to set parameters for a large variety of conditions. These data would be gathered from existing scenarios and historical conflicts as well as particular items of information pertaining to the elements of power for all states involved. The initial versions of this model might not produce satisfactory results because of the unknown relationships between various sub-systems. But as the system develops the model can be honed to precision. Every new element of information from every scenario involving national power can be added to the various look-up tables for every new condition. Eventually, as the model matures, the model and the resultant strategy could provide extremely accurate, in-depth, scientific analysis based on all the best classic theory planners and military professionals have come to trust. As a result, today's leaders could invariably improve their ability to create effective strategy using a quantifiable, logical, analytical system capable of robust examination of entire arrays of conditions.

A system such as this, however, does not come without a heavy price. The proposed system would take an immense amount of manpower to create the code, capture the historical data as sets of parameters, develop the relationships, and make the continuous improvements. The system would require years of testing, modifications, and re-testing. Finally, once the system was put into service, planners and strategists would require in-depth training. In addition, a system such as this would require a very expensive high speed processor with state-of-the-art security. In summary, a system such as this would take many years and millions, if not billions, of dollars to develop.

Once this system was developed, however, the country would have one of the most important weapons ever created. The value of an analytical tool that can reliably predict the best course of action for every objective, every scenario, and every crisis is priceless in terms of lives saved and security maintained. The effort involved and the resources expended to create such a tool would be relatively small and practically a moral obligation of military and civilian leadership to the citizens of this country.

WORD COUNT = 6844

ENDNOTES

¹ Eliot A. Cohen and John Gooch, *Military Misfortunes: The Anatomy of Failure in War* (New York: Vintage Books, 1991), 169.

² Eliot A. Cohen, *Supreme Command: Soldiers, Statesmen, and Leadership in Wartime* (New York: Free Press, 2002), 177.

³ Stephen Budiansky, "A Proven Formula for How Many Troops We Need," *The Washington Post*, 9 May 2004, sec B, p. 4 (1086 words) [database on line]; available from ProQuest; accessed 6 Jan 2005.

⁴ Victor Davis Hanson, "Do We Have Enough Troops In Iraq?" *Commentary* Vol. 117, Iss. 6 [database on line]; available from ProQuest; accessed 6 Jan 2005.

⁵ Edward N. Luttwak, *Strategy: The Logic of War and Peace* (Cambridge: Belknap Press 1987), 7.

⁶ *Ibid.*, 16.

⁷ Carl Von Clausewitz, *On War*, trans and ed by Michael Howard and Peter (Princeton, NJ: Princeton University Press, 1976), 168.

⁸ *Ibid.*, 152.

⁹ Patrick M. Cronin, "Clausewitz Condensed," in *Military Strategy: Theory and Application*, ed. Colonel Arthur F. Lykke, Jr. (Carlisle Barracks, PA: United States Army War College, 1993), 103.

¹⁰ Clausewitz, 595-96.

¹¹ *Ibid.*, 135.

¹² Bruce W. Fowler, *An Investigation of Mathematical Theories of Strategy*, Prepared For: U.S. Army Missile Command (Chicago: GACIAC, May, 1991), 5.

¹³ J.D. Hittle, "Jomini and His Summary of the Art of War," in *Military Strategy: Theory and Application*, ed. Colonel Arthur F. Lykke, Jr. (Carlisle Barracks, PA: United States Army War College, 1993), 114.

¹⁴ *Ibid.*, 119.

¹⁵ *Ibid.*, 120-21.

¹⁶ Sun Tzu, "The Art of War," in *Roots of Strategy*, ed. Major Thomas R. Phillips (Harrisburg, PA: Telegraph Press, 1950), 27.

¹⁷ J.C. Wylie, *Military Strategy: A General Theory of Power Control* (New Brunswick, NJ: Rutgers University Press, 1967), 7.

¹⁸ *Ibid.*, 72.

¹⁹ Ibid., 105.

²⁰ T.N. Dupuy, *Numbers, Predictions and War: Using History to Evaluate Combat Factors and Predict the Outcome of Battles* (Indianapolis: Bobbs-Merrill, 1979), ix.

²¹ Ibid., 43.

²² Ibid., 43-46.

²³ Ibid., 113.

²⁴ Barry D. Watts, "Ignoring Reality: Problems of Theory and Evidence in Security Studies," *Security Studies* Volume 7, Number 2 (Winter 1997/98): 117.

²⁵ Ibid., 118.

²⁶ Ibid., 119-120.

²⁷ Ibid., 121.

²⁸ Robert A. Pape, "The Air Force Strikes Back: A Reply to Barry Watts and John Warden," *Security Studies* Volume 7, Number 2 (Winter 1997/98): 196.

²⁹ Ibid., 197.

³⁰ Ibid., 198-200.

³¹ Clausewitz, p. 578.

³² Ibid.

³³ Ibid., 579.

³⁴ Ibid.

³⁵ Ibid., 585-594.

³⁶ Ibid., 596.

³⁷ Ibid., 599.

³⁸ Ibid., 605-610.

³⁹ Ibid., 617-637.

⁴⁰ J.D. Hittle, ed., *Jomini and His Summary of the Art of War* (Harrisburg, PA: Telegraph Press, 1947), 66-67.

⁴¹ Ibid., 67.

⁴² Ibid., 70.

⁴³ Ibid., 102., 56.

⁴⁴ Wylie, 88-93.

⁴⁵ Arthur F. Lykke, Jr., "Toward An Understanding of Military Strategy," in *U.S. Army War College Guide to Strategy*, ed. Joseph R. Cerami and James F. Holcolm, Jr. (Carlisle Barracks, PA: United States Army War College, 2001), 179-185.

⁴⁶ C. Robert Huckfeldt, *Dynamic Modeling: An Introduction* (Newbury Park: Sage Publications, 1982), 14.

⁴⁷ Ibid., 29.

⁴⁸ Ibid., 45.

⁴⁹ Ibid., 65.

⁵⁰ Jack Snyder, "Richness, Rigor, and Relevance in the Study of Soviet Foreign Policy," *International Security* Volume 9 Number 3 (Winter 1984-85): 91-92.

⁵¹ Kenneth Snow, "Theories of Organizational & Social Systems: A Transitioning Russian Perspective." *Futuristics* Volume 26, Number 1 & 2 (2002): 20 [database on line]; available from ProQuest; accessed 4 Feb 2005.

⁵² Alan F. Karr, *A Generalized Stochastic Lanchester Attrition Process* (Arlington, VA: Institute for Defense Analysis, 1975), iv.

⁵³ T.N. Dupuy, *Understanding War: History and Theory of Combat* (New York: Paragon House Publishers, 1987).

⁵⁴ Steven Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton, NJ: Princeton University Press, 2004), 2.

⁵⁵ Ibid., 10.

⁵⁶ Ibid., 18.

⁵⁷ Ibid., 209.

⁵⁸ Ian Bellany, "Modeling War," in *Journal of Peace Research* Volume 36 Number 6 (November 1999), 729.

BIBLIOGRAPHY

- Biddle, Steven. *Military Power: Explaining Victory and Defeat in Modern Battle*. Princeton, NJ: Princeton University Press, 2004.
- Bellany, Ian. "Modeling War," *Journal of Peace Research* Volume 36 Number 6 (November 1999): 729-737.
- Budiansky, Stephen. "A Proven Formula for How Many Troops We Need." *The Washington Post*, 9 May 2004, sec B, p. 4 (1086 words). Database on line. Available from ProQuest. Accessed 6 Jan 2005.
- Clausewitz, Carl Von. *On War*. Translated and edited by Michael Howard and Peter Paret. Princeton, New Jersey: Princeton University, 1976.
- Cohen, Elliot A. and John Gooch. *Military Misfortunes: The Anatomy of Failure in War*. New York: Vintage Books, 1991.
- Cronin, Patrick M. "Clausewitz Condensed," in *Military Strategy: Theory and Application*, ed. Colonel Arthur F. Lykke, Jr., 98-107. Carlisle Barracks, PA: United States Army War College, 1993.
- Dupuy, T.N. *Numbers, Predictions and War: Using History to Evaluate Combat Factors and Predict the Outcome of Battles*, Indianapolis: Bobbs-Merrill, 1979.
- _____. *Understanding War: History and Theory of Combat*. New York: Paragon House Publishers, 1987.
- Fowler, Bruce W. *An Investigation of Mathematical Theories of Strategy*, Prepared For: U.S. Army Missile Command. Chicago: GACIAC, May, 1991.
- Hanson, Victor Davis. "Do We Have Enough Troops In Iraq?" *Commentary* Vol. 117, Iss. 6. Database on line. Available from ProQuest. Accessed 6 Jan 2005.
- Hittle, J.D. "Jomini and His Summary of the Art of War," in *Military Strategy: Theory and Application*, ed. Colonel Arthur F. Lykke, Jr., 108-142. Carlisle Barracks, PA: United States Army War College, 1993.
- _____, ed. *Jomini and His Summary of the Art of War*. Harrisburg, PA: Telegraph Press, 1947.
- Huckfeldt, C. Robert. *Dynamic Modeling: An Introduction*. Newbury Park: Sage Publications, 1982.
- Karr, Alan F. *A Generalized Stochastic Lanchester Attrition Process*. Arlington, VA: Institute for Defense Analysis, 1975.
- Luttwak, Edward N. *Strategy: The Logic of War and Peace*. Cambridge: Belknap Press 1987.

- Lykke, Arthur F. "Toward an Understanding of Military Strategy," in *U.S. Army War College Guide to Strategy*, ed. Joseph R. Cerami and James F. Holcolm, Jr., 179-185. Carlisle Barracks, PA: United States Army War College, 2001.
- Pape, Robert A. "The Air Force Strikes Back: A Reply to Barry Watts and John Warden," *Security Studies* Volume 7, Number 2 (Winter 1997/98): 191-214.
- Snyder, Jack. "Richness, Rigor, and Relevance in the Study of Soviet Foreign Policy," *International Security* Volume 9 Number 3 (Winter 1984-85): 89-108.
- Snow, Kenneth. "Theories of Organizational & Social Systems: A Transitioning Russian Perspective." *Futuristics* Volume 26, Number 1 & 2 (2002): 20-36. Database on line. Available from ProQuest. Accessed 4 Feb 2005.
- Tzu, Sun. "The Art of War", in *Roots of Strategy*, ed. Major Thomas R. Phillips, 13-63. Harrisburg, PA: Telegraph Press, 1950.
- Watts, Barry D. "Ignoring Reality: Problems of Theory and Evidence in Security Studies," *Security Studies* Volume 7, Number 2 (Winter 1997/98): 115-171.
- Wylie, J.C. *Military Strategy: A General Theory of Power Control*. New Brunswick, NJ: Rutgers University Press, 1967.